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(54) CODE DISC AND ENCODER

(57) Disclosed are a code disc and an encoder. The code disc includes a code channel component obtained by coding according to a set coding mode, and a fixed grating corresponding to the code channel component; the coding mode is configured to increase a width of an absolute window of the code channel component. By the solution of the disclosure, problems that the absolute signal window becomes narrower as the number of reticles of the incremental code channel increases and accordingly the reliability of the encoder is reduced are solved, thereby improving the reliability of the encoder.

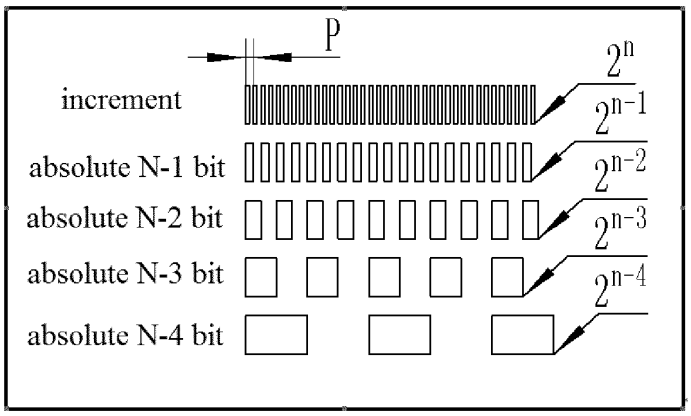

FIG. 1

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Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority to Chinese Patent Application with No. 201811517405.7, entitled "Code Disc and Encoder", and filed on December 12, 2018, the content of which is expressly incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of encoder technology, and specifically relates to a code disc and an encoder, and more particular to a code disc for an absolute encoder and a photoelectric encoder.

BACKGROUND

[0003] The photoelectric encoder is an angle measuring device that integrates light, machine and electricity, which converts optical signals into electrical signals through the mechanical structures and signal processing circuits, thereby implementing direct or indirect measurement of various physical quantities such as a diagonal displacement, a position and a speed.

[0004] The coding mode and fixed grating of the absolute encoder in the related art are shown in FIGS. 1 and 2. The incremental code channel is configured to obtain the sine and cosine signals to further subdivide and accordingly improve the resolution of the encoder; the absolute signal adopts the binary coding to provide the absolute position of the encoder. The window width of the absolute signal is a grating pitch *P* of the incremental signal. As the number of incremental code channel increases, the grating pitch *P* gradually decreases, resulting in that the absolute signal window becomes narrow, the PD (photodiode array) photosensitivity is insufficient, the instability of signal output is increased, the probability of error codes for absolute signals is significantly increased, and accordingly the reliability of the encoder is reduced.

SUMMARY

[0005] The purpose of the present disclosure is to provide a code disc and an encoder for the above-mentioned defects, so as to address the problems in the related art that the window of the absolute signal becomes narrower due to the increase in the number of the reticles of incremental code channels and accordingly the reliability of the encoder is reduced, thereby improving the reliability of the encoder.

[0006] The present disclosure provides a code disc, including: a code channel component obtained by coding according to a set coding mode, and a fixed grating corresponding to the code channel component; the coding mode is configured to increase a width of an absolute window of the code channel component.

[0007] Optionally, the code channel component includes: more than one incremental code channel and more than one absolute code channel; reticles of the more than one incremental code channel and the more than one absolute code channel are uniformly distributed with alternate light and dark.

[0008] Optionally, when a coding bit number N of the code disc is equal to four, the more than one incremental code channel and the more than one absolute code channel include: a first incremental code channel, a second incremental code channel, a *(N-3)-th* absolute code channel and a *(N-4)-th* absolute code channel; reticles of the first incremental code channel, the second incremental code channel, the *(N-3)-th* absolute code channel, and the *(N-4)-th* absolute code channel are uniformly distributed with alternate light and dark.

[0009] Optionally, a reticle period of the second incremental code channel is *M* times that of the first incremental code channel, and a reticle period of the *(N-3)-th* absolute code channel is *2M* times that of the first incremental code channel, and a reticle period of the *(N-4)-th* absolute code channel is *4M* times that of the first incremental code channel, *M* is a natural number.

[0010] Optionally, the fixed grating includes: more than one incremental window and more than one absolute window; the more than one absolute window is distributed on a periphery of the more than one incremental window.

[0011] Optionally, when the coding bit number *N* of the code disk is equal to four, the more than one incremental window and the more than one absolute window include: a first incremental window, a second incremental window, a *(N-3)-th* absolute window and a *(N-4)-th* absolute window; the first incremental window includes four portions arranged by using a four-quadrant split phase method to generate signals A, /A, and B, /B which are configured to obtain sine and cosine signals; the second incremental window includes two portions phases of which are staggered by 90° to generate two square wave signals with a phase difference of 90°, the two square wave signals are configured to generate a first bit and a second bit of the absolute signal; the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are configured to generate a third bit and a fourth bit of the absolute signal.

[0012] Optionally, a window width of the second incremental window is *P* times that of the first incremental window, and *P* is a natural number; and/or, window widths of the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are *2P* times the window width of the first incremental window, and *P* is a natural number.

[0013] Optionally, the window width of the second incremental window is *P* times that of the first incremental window, P is a natural number; and/or, the window widths of the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are *2P* times the window width of the first incremental window, and P is a natural number. The present disclosure in another aspect provides an encoder to

match the above code disc, including an encoder body and the above-mentioned code disc.

[0014] Optionally, the encoder further includes an LED, a photosensitive unit and a signal processing circuit; the encoder body, the code disc, the LED, the photosensitive unit and the signal processing circuit form a photoelectric encoder.

[0015] In the solution of the present disclosure, by increasing the width of the absolute window, the PD photosensitivity can be guaranteed, the stability of the absolute signal can be improved, and the reliability of the encoder in the application process can be guaranteed.

[0016] Furthermore, in the solution of the present disclosure, by increasing the width of the absolute window, the number of code channels of the grating can be decreased on the premise of the same encoder bits, which is beneficial to the miniaturization of the encoder.

[0017] Therefore, in the solution of the present disclosure, by increasing the width of the absolute window, the PD photosensitivity can be guaranteed, and the problems in the related art that the absolute signal window becomes narrower as the number of reticles of the incremental code channel increases and accordingly the reliability of the encoder is reduced (e.g., the window width of the absolute signal is equal to a grating pitch *P* of the incremental signal, the grating pitch *P* gradually decreases with the increase of the number of reticles of the incremental code channels, which results in narrowing of the window of the absolute signal window, thereby the reliability of the encoder is reduced). Therefore, defects of narrow window width of the absolute window, low stability of the absolute signal and low reliability of the encoder in related art are overcome; and advantages of wide window width of the absolute window, good stability of the absolute signal and high reliability of the encoder are achieved.

[0018] Other features and advantages of the present disclosure will be described in the following specification, and partly become apparent from the specification, or understood by implementing the present disclosure.

[0019] The technical solution of the present disclosure will be further detailed below through the accompanying drawings and embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a schematic structure diagram of a coding mode of an existing code disc (such as a code disc of an absolute encoder).

FIG. 2 is a schematic structure diagram of a fixed grating of an existing code disc (such as a code disc of an absolute encoder).

FIG. 3 is a schematic structure diagram of a coding mode of a code disk (such as a code disk of an absolute encoder) according to an embodiment the present disclosure.

FIG. 4 is a schematic structure diagram of a fixed grating of a code disc (such as a code disc of an absolute encoder) according to an embodiment of the present disclosure.

FIG. 5 is a schematic waveform diagram of an output signal of a code disc (such as a code disc of an absolute encoder) according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0021] In order to make the purpose, technical solution, and advantages of the present disclosure clearer, the technical solution of the present disclosure will be described clearly and completely in conjunction with specific embodiments of the present disclosure and corresponding accompanying drawings. Apparently, the described embodiments are merely some embodiments of the present disclosure, rather than all the embodiments. Based on the embodiments in the present disclosure, all other embodiments obtained by those of ordinary skill in the art without creative work shall fall within the protection scope of the present disclosure.

[0022] According to an embodiment of the present disclosure, a code disc (such as a code disc of an absolute encoder) is provided, with reference to a schematic structure diagram of a code disc according to an embodiment of the present disclosure shown in FIG. 3. The code disk includes: a code channel component obtained by coding according to a set coding mode, and a fixed grating corresponding to the code channel component.

[0023] The above-mentioned coding mode can be configured to increase a width of an absolute window of the code channel component.

[0024] For example, a coding mode of an encoder and a corresponding fixed grating are provided to increase the width of the absolute window, ensure the PD photosensitivity, improve the stability of the absolute signal, and ensure the reliability of the encoder in the application process; at the same time, under the premise of the same encoder bits, the number of code channels of the grating can be reduced, which is beneficial to the miniaturization of the encoder.

[0025] Therefore, the required code channel component is obtained through the coding mode of increasing the width of the absolute window of the code channel component, and the fixed grating corresponding to the code channel component is obtained, which can increase the width of the absolute window, thereby improving the stability of the absolute signal and ensuring the reliability of the encoder in the application process.

[0026] In an optional example, the above-mentioned code channel component includes more than one incremental code channel and more than one absolute code channel.

[0027] The above-mentioned more than one incremental code channel and more than one absolute code channel are arranged in sequence (such as from top to

bottom, or from left to right), and reticles of the more than one incremental code channel and more than one absolute code channel are uniformly distributed with alternate light and dark.

[0028] Therefore, the reticles of the incremental code channel and the absolute code channel in the code channel component are uniformly distributed with alternate light and dark, which is beneficial to increase the width of the absolute window, ensure the PD photosensitivity, and improve the stability of the absolute signal.

[0029] Optionally, when the coding bit number *N* of the code disk is equal to 4 (*N* is a natural number), the more than one incremental code channel and more than one absolute code channel may include: a first incremental code channel (such as an incremental code channel 1), a second incremental code channel (such as an incremental code channel 2), a *(N-3)-th* absolute code channel (such as an absolute code channel *N-3*) and a *(N-4)-th* absolute code channel (such as an absolute code channel *N-4*).

[0030] Reticles of the first incremental code channel, the second incremental code channel, the *(N-3)-th* absolute code channel, and the *(N-4)-th* absolute code channel are uniformly distributed with alternate light and dark.

[0031] For example, the principle of the coding mode of the encoder is shown in FIG. 3, which consists of an incremental code channel 1, an incremental code channel 2, an absolute code channel *N-3,* and an absolute code channel *N-4.* The corresponding fixed grating is shown in FIG. 4, which consists of an increment 1 window, an increment 2 window, an absolute *N-3* window, and an absolute *N-4* window. Reticles of the above-mentioned incremental code channel 1, incremental code channel 2, absolute code channel *N-3* and absolute code channel *N-4* are uniformly distributed with alternate light and dark. *N* is the number of bits of the binary encoder.

[0032] Therefore, the reticles of the incremental code channel and the absolute code channel in the code channel component when the coding bit number *N* is 4 are uniformly distributed with alternate light and dark, which is beneficial to increase the width of the absolute window, ensure the PD photosensitivity and improve the stability of the absolute signal.

[0033] More optionally, a reticle period of the second incremental code channel is equal to *M* times that of the first incremental code channel, and a reticle period of the *(N-3)-th* absolute code channel is equal to *2M* times that of the first incremental code channel. A reticle period of the *(N-4)-th* absolute code channel is equal to *4M* times that of the first incremental code channel; and *M* is a natural number.

[0034] For example, the reticle period of the incremental code channel 2 is equal to 4 times that of the incremental code channel 1; the reticle period of the absolute code channel *N-3* is equal to 8 times that of the incremental code channel 1; and the reticle period of the absolute code channel *N-4* is equal to 16 times that of the incremental code channel 1.

[0035] Therefore, in the code channel component, when the coding bit number *N* is equal to 4, the reticle period of the first incremental code channel is used as a reference, and the reticle periods of other incremental code channels and the absolute code channels are set to multiple of the reference, which is beneficial to increase the width of the absolute window and improve the stability of the encoder.

[0036] In an optional example, the above-mentioned fixed grating may include: more than one incremental window and more than one absolute window.

[0037] The more than one absolute window is distributed on a periphery of the more than one incremental window.

[0038] Therefore, the absolute window is distributed on the periphery of the incremental window in the fixed grating, which is beneficial to increase the width of the absolute signal and ensure the PD photosensitivity.

[0039] Optionally, when the coding bit number *N* of the code disk is equal to 4 (N is a natural number), the more than one incremental window and the more than one absolute window may include a first incremental window (such as an incremental 1 window), a second incremental window (such as an incremental 2 window), a *(N-3)-th* absolute window (such as an absolute *N-3* window) and a *(N-4)-th* absolute window (such as an absolute *N-4* window).

[0040] Specifically, the above-mentioned first incremental window includes four portions arranged by a four-quadrant split phase method to generate signals A, /A, B, and /B, which can be configured to obtain sine and cosine signals through a set signal processing.

[0041] For example, the above-mentioned increment 1 window contains four portions arranged by using the four-quadrant split phase method to generate signals A, /A, B, and /B, which are processed by a subsequent circuit to obtain sine and cosine signals. The waveforms indicated by A and B in FIG. 5 are used for signal subdivision to improve the encoder resolution.

[0042] Specifically, the above-mentioned second incremental window includes two portions phases of which are staggered by 90° to generate two square wave signals with a phase difference of 90°, which can be configured to generate a first bit and a second bit of the absolute signal through the set calculation and processing.

[0043] For example, the above-mentioned increment 2 window with the window width thereof equal to 4 times that of the increment 1 window, includes two portions which are staggered by 90° and generate two square wave signals with a phase difference of 90°; the waveforms are indicated by C, D in FIG. 5, and the two square wave signals generate the first and second bits of the absolute signal through calculation.

[0044] Specifically, the above-mentioned *(N-3)-th* absolute window and the *(N-4)-th* absolute window can be configured to generate the *3-rd* and *4-th* bits of the absolute signal.

[0045] For example, the above-mentioned absolute *N-3* window and absolute *N-4* window with the window widths thereof 8 times that of the increment 1 window, are configured to generate the third and fourth bits of the absolute signal, with the waveforms indicated by E and F in FIG. 5. In FIG. 5, the absolute codes formed by C, D, E, F are 1111, 1110, 1100, 1101, 1011, 1010, 1000, 1001, 0111, 0110, 0100, 0101, 0011, 0010, 0000, 0001, i.e., there are sixteen codes in total without duplication, accordingly the purpose of four-bit coding is achieved.

[0046] Therefore, the incremental window and the absolute window are provided in the fixed grating to generate the signal, which is beneficial to improve the stability of the absolute signal.

[0047] More optionally, the window width of the second incremental window is *P* times that of the first incremental window, and *P* is a natural number.

[0048] More optionally, the window widths of the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are *2P* times the window width of the first incremental window; *P* is a natural number.

[0049] More optionally, the window width of the second incremental window is *P* times that of the first incremental window, and the window widths of the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are *2P* times the window width of the first incremental window; and *P* is a natural number.

[0050] Therefore, in a fixed grating, when the coding bit number N is 4, the window width of the first incremental window is used as the reference, and the window widths of other incremental windows and absolute windows are set as multiple of the reference, Which is beneficial to increase the width of the absolute window and improve the stability of the encoder.

[0051] It has been verified by a large number of experiments that by increasing the width of the absolute window using the technical solution of the present disclosure, the PD photosensitivity can be guaranteed, the stability of the absolute signal can be improved, and the reliability of the encoder in the application process can be guaranteed.

[0052] According to embodiments of the present disclosure, an encoder corresponding to a code disc is further provided. The encoder can include an encoder body. In addition, the encoder can further include the above-mentioned code disc.

[0053] Optionally, the encoder can further include: an LED, a photosensitive unit, and a signal processing circuit.

[0054] The encoder body, the code disc, the LED, the photosensitive unit, and the signal processing circuit form a photoelectric encoder.

[0055] For example, a photoelectric encoder can include: a structural body, an LED, a photosensitive unit, a signal processing circuit, and a code disc; it is characterized by adopting the above-mentioned coding mode and a fixed grating.

[0056] The structural body is a body structure of the encoder, which can include: a shaft, a bracket, a bearing, a nut, etc.

[0057] Therefore, the required code channel component is obtained by the coding mode of increasing the width of the absolute window of the code channel component, and the fixed grating corresponding to the code channel component is obtained, which can increase the width of the absolute window, thereby improving the stability of the absolute signal and ensuring the reliability of the photoelectric encoder in the application process.

[0058] In an optional embodiment, in order to solve the problems that the absolute signal window becomes narrower as the number of reticles of the incremental code channel increases and the reliability of the encoder is reduced, the solution of the present disclosure provides an encoder coding mode and a corresponding fixed grating to increase the width of the absolute window, ensure the PD photosensitivity, improve the stability of the absolute signal, and ensure the reliability of the encoder in the application process; at the same time, under the premise of the same encoder bits, the number of code channels of the grating can be reduced, which is beneficial to the miniaturization of the encoder.

[0059] In an optional example, the solution of the present disclosure provides an encoder coding mode and a corresponding fixed grating to increase the width of the absolute window, ensure the PD photosensitivity, improve the stability of the absolute signal, and ensure the reliability of the encoder in the application process; at the same time, under the premise of the same encoder bits, the number of code channels of the grating can be reduced, which is beneficial to the miniaturization of the encoder.

[0060] Optionally, the solution of the present disclosure provides an absolute encoder dual-incremental code channel coding mode and a corresponding fixed grating, which can effectively ensure the width of the absolute window, increase the PD photosensitivity, ensure the stability of the absolute signal, and enhance the reliability of the encoder in the application process; at the same time, under the premise of the same encoder bits, the number of code channels of the grating can be decreased by one, which is beneficial to the miniaturization of the encoder.

[0061] It can be seen that the present disclosure provides an encoder coding mode and a corresponding fixed grating, which can increase the width of the absolute window, ensure the PD photosensitivity, solve the problem of insufficient photosensitivity of the photoelectric encoder to the window, improve the stability of the absolute signal, solve the problem of instability of the absolute signal of the photoelectric encoder in the application process, and ensure the reliability of the encoder in the application process; at the same time, under the premise of the same encoder bits, the number of code channels of the grating can be reduced, which is beneficial to the miniaturization of the encoder and solve the miniaturization problem of the photoelectric encoder.

[0062] In an optional specific embodiment, reference can be made to the examples shown in FIGS. 3 to 5, which illustrate the specific implementation process of the solution of the present disclosure.

[0063] For ease of presentation, *N=4* is taken as an example in the solution of the present disclosure.

[0064] In an optional specific example, in the solution of the present disclosure, the principle of the encoder coding mode is shown in FIG. 3, which consists of an incremental code channel 1, an incremental code channel 2, an absolute code channel *N-3,* and an absolute code channel *N-4.* The corresponding fixed grating is shown in FIG. 4, which consists of an increment 1 window, an increment 2 window, an absolute *N-3* window, and an absolute *N-4* window.

[0065] Optionally, the reticles of the above incremental code channel 1, incremental code channel 2, absolute code channel *N-3,* and absolute code channel *N-4* are uniformly distributed with alternate light and dark.

[0066] The reticle period of the incremental code channel 2 is 4 times that of the incremental code channel 1; the reticle period of the absolute code channel *N-3* is 8 times that of the incremental code channel 1; and the reticle period of the absolute code channel *N-4* is 16 times that of the incremental code channel 1. The multiple can be a fixed value and does not change according to the value of *N.*

[0067] Optionally, the above-mentioned increment 1 window, including four portions arranged by using the 4-quadrant split phase method, generates signals A, /A, B, and /B, and obtains sine and cosine signals through the subsequent circuit processing. The waveforms indicated by A, B shown in FIG. 5 are used for signal subdivision to improve the resolution of the encoder.

[0068] The subsequent processing may include: signal conditioning, signal amplification, and signal filtering processing, etc.

[0069] Optionally, the window width of the increment 2 window is 4 times the window width of the increment 1 window, and includes two portions, phases of which are staggered by 90° to generate two square wave signals with a phase difference of 90°. The waveforms are indicated by C, D shown in FIG. 5, and the two square wave signals generate the first and second bits of the absolute signal through calculation.

[0070] Optionally, the window widths of the above-mentioned absolute *N-3* window and absolute *N-4* window are 8 times the window width of the increment 1 window, and are configured to generate the third and fourth bits of the absolute signal. The waveforms are indicated by E and F shown in FIG. 5.

[0071] In FIG. 5, the absolute codes formed by C,D,E, F are 1111, 1110, 1100, 1101, 1011, 1010, 1000, 1001, 0111, 0110, 0100, 0101, 0011, 0010, 0000, 0001, i.e., there are sixteen codes in total without duplication, accordingly the purpose of four-bit coding is achieved.

[0072] By comparison, the width of the absolute window of the encoder using the above-mentioned coding mode is 4 times the width of the absolute window in the related art, which improves the PD photosensitivity, ensures the stability of the absolute signal, and enhances the reliability of the encoder in the application process; at the same time, under the premise of the same encoder bits, the number of code channels of the grating can be decreased by one, which is beneficial to the miniaturization of the encoder.

[0073] Since the processing and functions implemented by the encoder in this embodiment basically correspond to the embodiments, principles, and examples of the code disc shown in FIGS. 3 to 5, as for the description in this embodiment not exhaustive, reference can be made to the relevant description in the aforementioned embodiments, which will not be repeated here.

[0074] It has been verified by a large number of experiments that, by using the technical solution of the present disclosure, the number of code channels of the grating can be decreased by increasing the width of the absolute window under the premise of the same encoder bits, which is beneficial to the miniaturization of the encoder.

[0075] In conclusion, it is easy for those skilled in the art to understand that the above advantageous modes can be freely combined and superimposed on the premise of no conflict.

[0076] The above descriptions are merely embodiments of the present disclosure and are not intended to limit the present disclosure. For those skilled in the art, the present disclosure may have various modifications and changes. Any modification, equivalent replacement, improvement, etc., made within the spirit and principle of the present disclosure shall fall within the scope of protection of the claims of the present disclosure.

Claims

1. A code disc, comprising: a code channel component obtained by coding according to a set coding mode, and a fixed grating corresponding to the code channel component,
   wherein, the coding mode is configured to increase a width of an absolute window of the code channel component.

2. The code disc according to claim 1, wherein the code channel component comprises: more than one incremental code channel and more than one absolute code channel;
   reticles of the more than one incremental code channel and the more than one absolute code channel are uniformly distributed with alternate light and dark.

3. The code disc according to claim 2, wherein when a coding bit number *N* of the code disc is equal to four, the more than one incremental code channel and the more than one absolute code channel comprise: a first incremental code channel, a second incremen-

tal code channel, a *(N-3)-th* absolute code channel and a *(N-4)-th* absolute code channel;
reticles of the first incremental code channel, the second incremental code channel, the *(N-3)-th* absolute code channel, and the *(N-4)-th* absolute code channel are uniformly distributed with alternate light and dark.

4. The code disc according to claim 3, wherein a reticle period of the second incremental code channel is *M* times that of the first incremental code channel, and a reticle period of the *(N-3)-th* absolute code channel is *2M* times that of the first incremental code channel, and a reticle period of the *(N-4)-th* absolute code channel is *4M* times that of the first incremental code channel, *M* is a natural number.

5. The code disc according to any one of claims 1 to 4, wherein the fixed grating comprises: more than one incremental window and more than one absolute window;
the more than one absolute window is distributed on a periphery of the more than one incremental window.

6. The code disk according to claim 5, wherein when the coding bit number *N* of the code disk is equal to four, the more than one incremental window and the more than one absolute window comprise: a first incremental window, a second incremental window, a *(N-3)-th* absolute window and a *(N-4)-th* absolute window;
the first incremental window comprises four portions arranged by using a four-quadrant split phase method to generate signals A, /A, and B, /B which are configured to obtain sine and cosine signals;
the second incremental window comprises two portions phases of which are staggered by 90° to generate two square wave signals with a phase difference of 90°, the two square wave signals are configured to generate a first bit and a second bit of the absolute signal; the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are configured to generate a third bit and a fourth bit of the absolute signal.

7. The code disc according to claim 6, wherein:

a window width of the second incremental window is *P* times that of the first incremental window, and *P* is a natural number.

8. The code disc according to claim 6, wherein window widths of the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are *2P* times the window width of the first incremental window, and *P* is a natural number.

9. The code disc according to claim 6, wherein the window width of the second incremental window is *P* times that of the first incremental window, and the window widths of the *(N-3)-th* absolute window and the *(N-4)-th* absolute window are *2P* times the window width of the first incremental window, and *P* is a natural number.

10. An encoder, comprising an encoder body and the code disc according to any one of claims 1 to 9.

11. The encoder according to claim 10, further comprising an LED, a photosensitive unit and a signal processing circuit, wherein
the encoder body, the code disc, the LED, the photosensitive unit and the signal processing circuit form a photoelectric encoder.

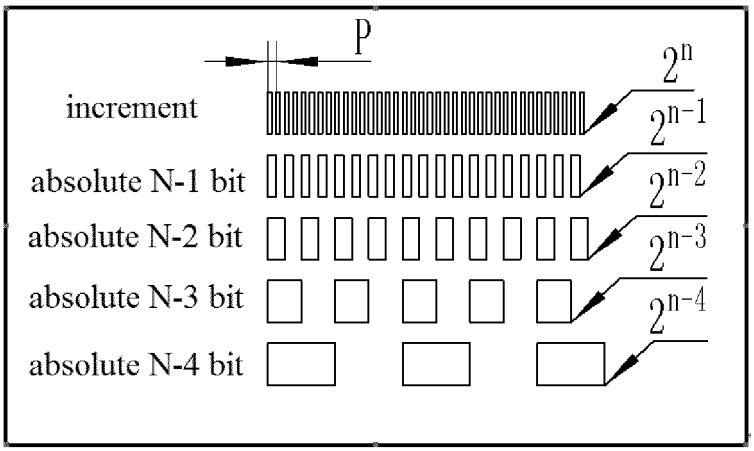
P
increment
absolute N-1 bit
absolute N-2 bit
absolute N-3 bit
absolute N-4 bit
2^n
2^n-1
2^n-2
2^n-3
2^n-4

FIG. 1

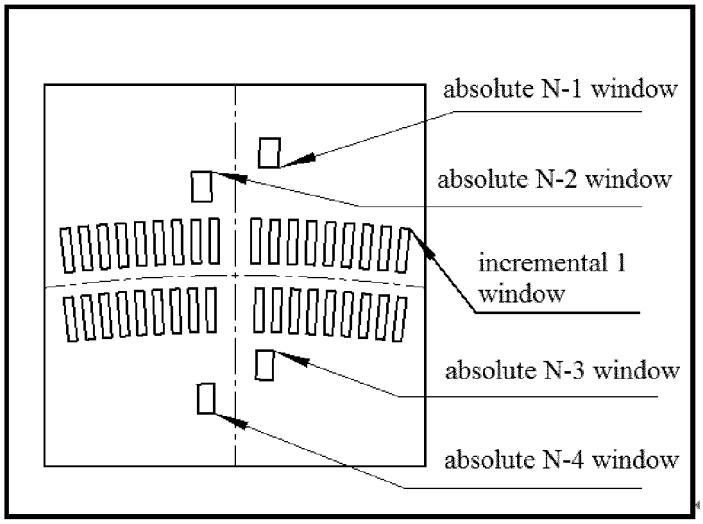
absolute N-1 window
absolute N-2 window
incremental 1 window
absolute N-3 window
absolute N-4 window

FIG. 2

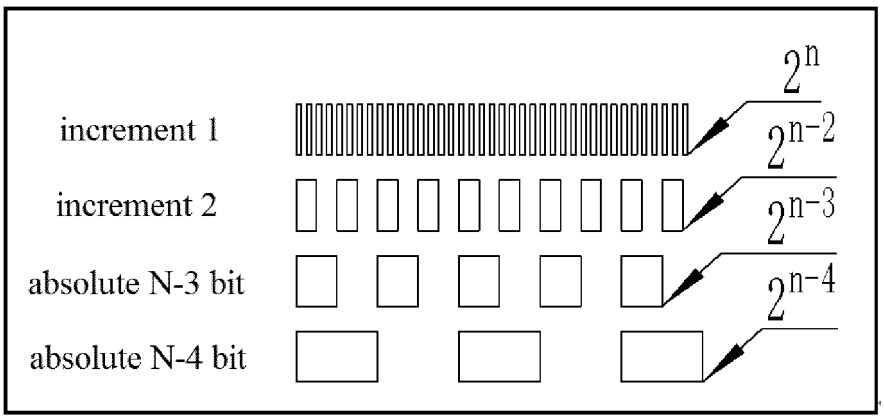
increment 1
increment 2
absolute N-3 bit
absolute N-4 bit
2^n
2^{n-2}
2^{n-3}
2^{n-4}

FIG. 3

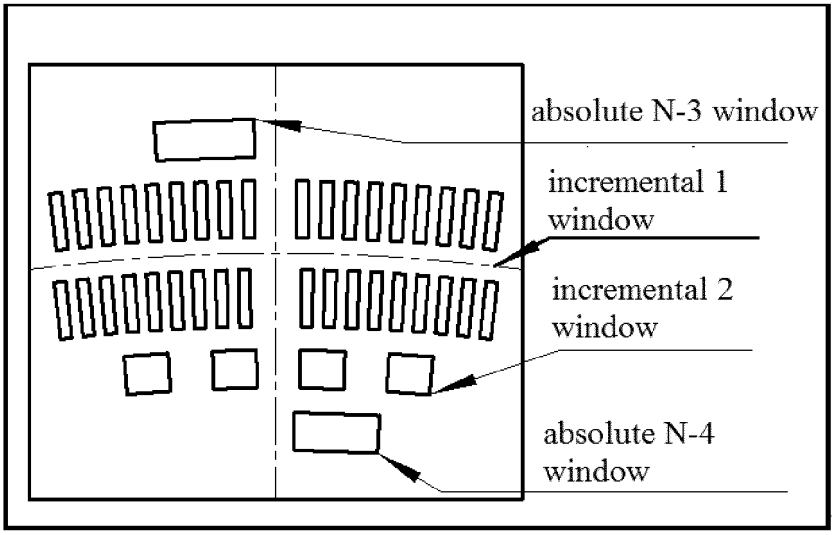
absolute N-3 window
incremental 1 window
incremental 2 window
absolute N-4 window

FIG. 4

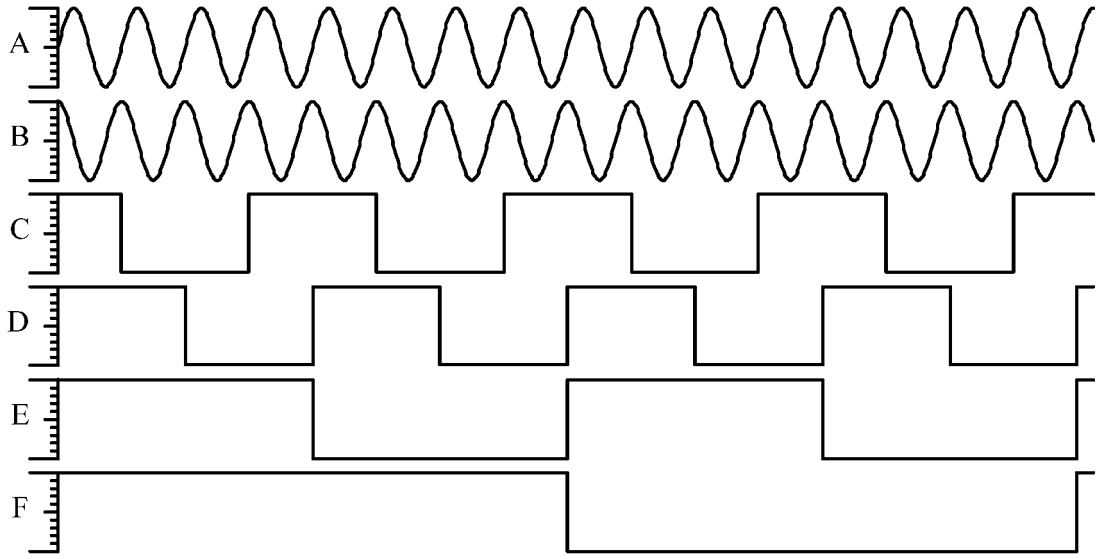

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/104776

A. CLASSIFICATION OF SUBJECT MATTER

G01D 5/347(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS; CNTXT; VEN; WOTXT; EPTXT; USTXT; CNKI; IEEE: 码盘, 码道, 定光栅, 窗口, 宽度, 增量, 绝对, 正弦, 余弦, 方波, 编码器, disc, encoder, code, track, fix+ grating, width, absolute, window, increment, square wave

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 109443402 A (GREE ELECTRIC APPLIANCES, INC. OF ZHUHAI) 08 March 2019 (2019-03-08) description, paragraphs [0005]-[0013], and figures 1-5	1-11
Y	CN 106092163 A (GREE GREEN REFRIGERATION TECHNOLOGY CENTER CO., LTD. OF ZHUHAI) 09 November 2016 (2016-11-09) description, paragraphs [0003] and [0034], and figure 2	1-5, 10, 11
Y	CN 104614000 A (YASKAWA ELECTRIC CORPORATION) 13 May 2015 (2015-05-13) description, paragraphs [0049] and [0050], and figures 3-5	1-5, 10, 11
A	CN 106248117 A (GREE GREEN REFRIGERATION TECHNOLOGY CENTER CO., LTD. OF ZHUHAI) 21 December 2016 (2016-12-21) entire document	1-11
A	CN 106706012 A (CHANGZHOU XINRUIDE INSTRUMENT CO., LTD.) 24 May 2017 (2017-05-24) entire document	1-11

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 October 2019	**15 November 2019**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration** **No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/104776

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	109443402	A	08 March 2019	CN	209342121	U	03 September 2019
CN	106092163	A	09 November 2016	CN	106092163	B	30 November 2018
CN	104614000	A	13 May 2015	JP	2015090309	A	11 May 2015
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				US	9423279	B2	23 August 2016
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				CN	104614000	B	20 June 2017
				EP	2869033	A1	06 May 2015
				US	2015123585	A1	07 May 2015
				EP	2869033	B1	14 September 2016
				SG	10201407181	A1	28 May 2015
				BR	102014027602	A2	15 September 2015
				IN	201403118	I1	03 July 2015
				SG	10201407181	B	25 June 2015
CN	106248117	A	21 December 2016	CN	106248117	B	30 November 2018
CN	106706012	A	24 May 2017	CN	106706012	B	26 March 2019

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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